



## FCC SAR Compliance Test Report

Project Name: DC-HSPA+ USB Stick  
Model : E3251s-81  
FCC ID : QISE3251S-81  
Report No. : SYBH(Z-SAR)040042013-2

|      | APPROVED<br>(Manager) | CHECKED         | PREPARED      |
|------|-----------------------|-----------------|---------------|
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| DATE | 2013-05-24            | 2013-05-24      | 2013-05-24    |

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※ ※ **Modified History** ※ ※

| REV.    | DESCRIPTION   | ISSUED DATE | REMARK |
|---------|---|-------------|--------|
| Rev.1.0 | Initial Test Report Release   | 2013-05-18  | Li Wei |
| Rev.1.1 | 1) Updated the HSDPA/HSUPA/DC-HSDPA Conducted power table of UMTS Band II in part 7.1.3<br>2) Add the DC-HSDPA test configuration information in Part 6.2 | 2013-05-24  | Li Wei |
|         |   |             |        |
|         |   |             |        |
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|         |   |             |        |
|         |   |             |        |
|         |   |             |        |
|         |   |             |        |

## 1 General Information

### 1.1 Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for E3251s-81 are as below Table 1.

| Band         | Position | MAX Reported 1-g SAR (W/kg) |
|--------------|----------|-----------------------------|
| GSM850       | Body 5mm | 1.139                       |
| GSM1900      | Body 5mm | 1.020                       |
| UMTS Band II | Body 5mm | 1.164                       |

Table 1:Summary of test result

The device is in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits of 1.6 W/Kg as averaged over any 1 g tissue according to the FCC rule §2.1093, the ANSI/IEEE C95.1:1992, the NCRP Report Number 86 for uncontrolled environment, according to the Industry Canada Radio Standards Specification RSS-102 for General Population/Uncontrolled exposure, and had been tested in accordance with the measurement methods and procedures specified in IEEE Std 1528-2003 & IEEE Std 1528a-2005 and FCC OET Bulletin 65 Supplement C Edition 01-01.

### 1.2 RF exposure limits

| Human Exposure   | Uncontrolled Environment<br>General Population | Controlled Environment<br>Occupational |
|--|--|--|
| <b>Spatial Peak SAR*</b><br>(Brain/Body/Arms/Legs)     | <b>1.60 mW/g</b>                               | 8.00 mW/g                              |
| <b>Spatial Average SAR**</b><br>(Whole Body)           | 0.08 mW/g                                      | 0.40 mW/g                              |
| <b>Spatial Peak SAR***</b><br>(Hands/Feet/Ankle/Wrist) | 4.00 mW/g                                      | 20.00 mW/g                             |

Table 2: RF exposure limits

The limit applied in this test report is shown in **bold** letters

#### Notes:

- \* The Spatial Peak value of the SAR averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time
- \*\* The Spatial Average value of the SAR averaged over the whole body.
- \*\*\* The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

**Uncontrolled Environments** are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure.

**Controlled Environments** are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation.

### 1.3 EUT Description

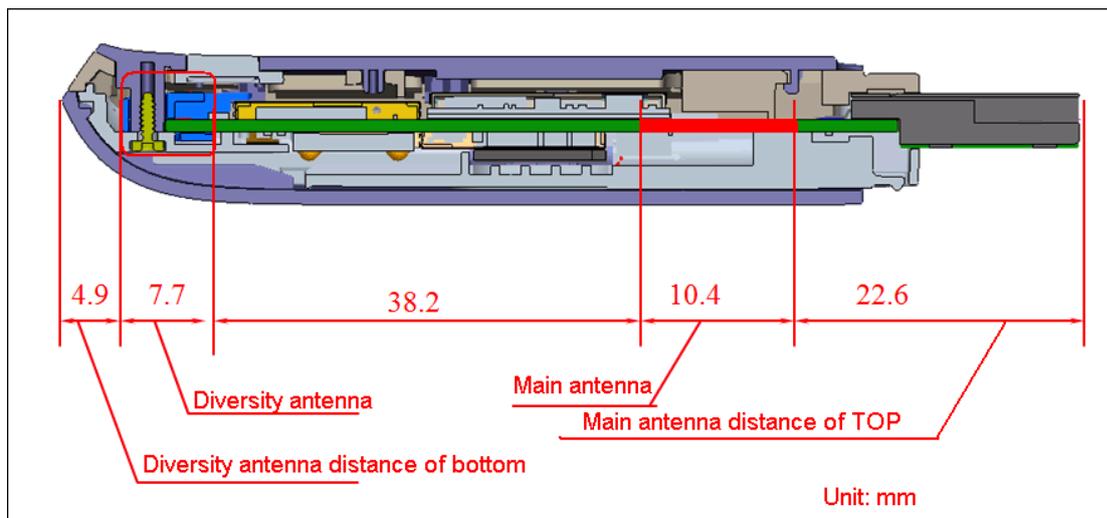
|                                  |  |           |           |
|----------------------------------|--|-----------|-----------|
| Device Information:              |  |           |           |
| DUT Name:                        | DC-HSPA+ USB Stick                                 |           |           |
| Type Identification:             | E3251s-81  |           |           |
| FCC ID:                          | QISE3251S-81                                       |           |           |
| SN No.:                          | N4R01A9350300022                                   |           |           |
| Device Type :                    | portable device                                    |           |           |
| Device Phase:                    | Identical Prototype                                |           |           |
| Sample Dimension:                | 86.5mmx26mmx11mm                                   |           |           |
| Exposure Category:               | uncontrolled environment / general population      |           |           |
| Hardware Version :               | CH2E3251SM   |           |           |
| Software Version :               | 21.146.01.00.00                                    |           |           |
| Antenna Type :                   | internal antenna                                   |           |           |
| Device Operating Configurations: |  |           |           |
| Supporting Mode(s)               | GSM850/1900,UMTS Band II (tested)                  |           |           |
| Test Modulation                  | GSM(GMSK/8PSK), UMTS(QPSK)                         |           |           |
| Device Class                     | B  |           |           |
| Operating Frequency Range(s)     | Band   | Tx (MHz)  | Rx (MHz)  |
|                                  | GSM850   | 824-849   | 869-894   |
|                                  | GSM1900  | 1850-1910 | 1930-1990 |
|                                  | UMTS Band II                                       | 1850-1910 | 1930-1990 |
| GPRS Multislot Class(12)         | Max Number of Timeslots in Uplink:                 | 4         |           |
|                                  | Max Number of Timeslots in Downlink:               | 4         |           |
|                                  | Max Total Timeslot:                                | 5         |           |
| EGPRS Multislot Class(12)        | Max Number of Timeslots in Uplink:                 | 4         |           |
|                                  | Max Number of Timeslots in Downlink:               | 4         |           |
|                                  | Max Total Timeslot:                                | 5         |           |
| HSDPA UE Category                | 14   |           |           |
| HSUPA UE Category:               | 6  |           |           |
| DC-HSDPA UE Category:            | 24   |           |           |
| Power Class:                     | 4, tested with power level 5(GSM850)               |           |           |
|                                  | 1, tested with power level 0(GSM1900)              |           |           |
|                                  | 3, tested with power control "all 1"(UMTS Band II) |           |           |
| Test Channels (low-mid-high):    | 128-190-251 (GSM850)                               |           |           |
|                                  | 512-661-810 (GSM1900)                              |           |           |
|                                  | 9262-9400-9538 (UMTS Band II)                      |           |           |

Table 3:Device information and operating configuration

### 1.3.1 General Description

E3251s-81 DC-HSPA+/WCDMA/EDGE/GPRS/GSM dual mode 7 bands USB Stick is subscriber equipment in the UMTS/GSM system. E3251s-81 implement such functions as RF signal receiving/transmitting, DC-HSPA+/WCDMA and EDGE/GPRS/GSM protocol processing, data service etc. Externally it provides USB interface (to connect to the notebook etc.), USIM card interface and Micro SD card interface.

The antennas picture of the EUT is as below :



#### 1.4 Test specification(s)

|   |  |
|---|--|
| ANSI C95.1-1992                                       | Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz – 300 GHz.( IEEE Std C95.1-1991)   |
| IEEE Std 1528-2003                                    | Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques  |
| IEEE Std 1528a-2005                                   | IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques<br>Amendment 1: CAD File for Human Head Model (SAM Phantom)           |
| OET Bulletin No. 65, Supplement C Edition 01-01– 2001 | Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields---Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions |
| RSS-102   | Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands (Issue 4 of March 2010)   |
| KDB941225 D01   | SAR test for 3G devices v02  |
| KDB941225 D03   | SAR Test Reduction GSM GPRS EDGE vo1   |
| KDB447498 D02   | SAR Procedures for Dongle Xmtr v02   |
| KDB447498 D01   | General RF Exposure Guidance v05   |
| KDB865664 D01   | SAR measurement 100 MHz to 6 GHz v01   |
| KDB865664 D02   | SAR Reporting v01  |
| KDB450824 D01   | SAR Probe Calibration and System Verification v01  |
| KDB450824 D02   | Dipole SAR Validation Verification v01   |

#### 1.5 Testing laboratory

|                        |   |
|------------------------|---|
| Test Site              | The Reliability Laboratory of Huawei Technologies Co., Ltd.   |
| Test Location          | Zone K3,Huawei Industrial Base, Bantian Industry Area, Longgang District, Shenzhen, Guangdong, China  |
| Telephone              | +86 755 28780808  |
| Fax                    | +86 755 89652518  |
| State of accreditation | The Test laboratory (area of testing) is accredited according to ISO/IEC 17025. CNAS Registration number: L0310<br>A2LA TESTING CERT #2174.01 |

#### 1.6 Applicant and Manufacturer

|              |   |
|--------------|---|
| Company Name | HUAWEI TECHNOLOGIES CO., LTD  |
| Address      | Administration Building, Headquarters of Huawei Technologies Co., Ltd., Bantian, Longgang District, Shenzhen, 518129, P.R.C |

#### 1.7 Application details

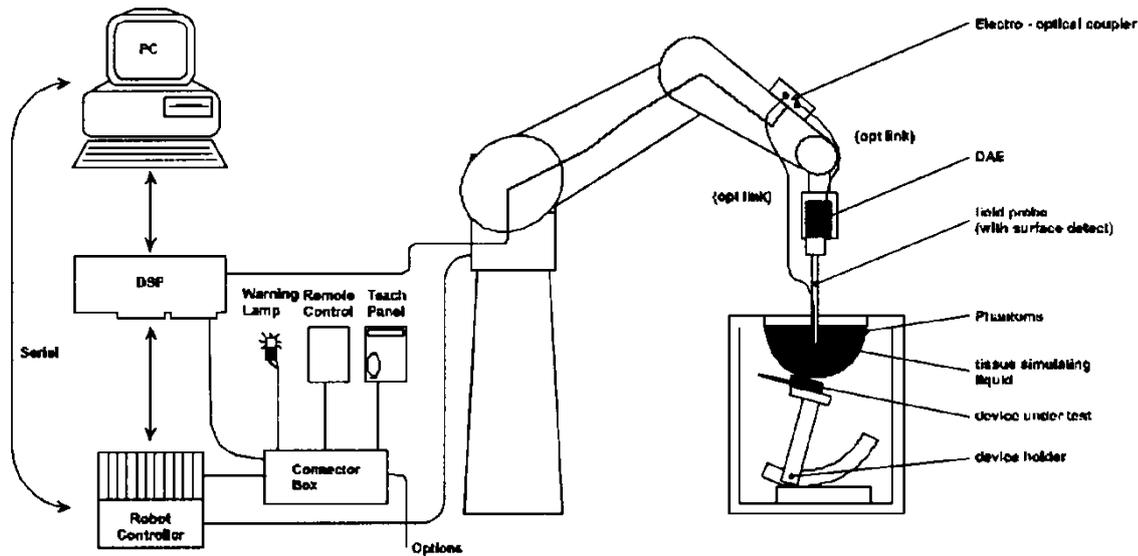
|                    |            |
|--------------------|------------|
| Start Date of test | 2013/04/28 |
| End Date of test   | 2013/05/02 |

#### 1.8 Ambient Condition

|                     |             |
|---------------------|-------------|
| Ambient temperature | 20°C – 24°C |
| Relative Humidity   | 30% – 70%   |

## 2 SAR Measurement System

### 2.1 SAR Measurement Set-up



The DASY5 system for performing compliance tests consists of the following items:

- A standard high precision 6-axis robot (Stäubli RX family) with controller and software. An arm extension for accommodating the data acquisition electronics (DAE).
- A dosimetric probe, i.e. an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
- A data acquisition electronic (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- A unit to operate the optical surface detector which is connected to the EOC.
- The Electro-Optical Coupler (EOC) performs the conversion from the optical into a digital electric signal of the DAE. The EOC is connected to the DASY5 measurement server.
- The DASY5 measurement server, which performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation. A computer operating Windows XP.
- DASY5 software and SEMCAD data evaluation software.
- Remote control with teach panel and additional circuitry for robot safety such as warning lamps, etc.
- The generic twin phantom enabling the testing of left-hand and right-hand usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes.
- System check dipoles allowing to validate the proper functioning of the system.

**2.2 Test environment**

The DASY4 measurement system is placed at the head end of a room with dimensions: 5 x 2.5 x 3 m<sup>3</sup>, the SAM phantom is placed in a distance of 75 cm from the side walls and 1.1m from the rear wall. Above the test system a 1.5 x 1.5 m<sup>2</sup> array of pyramid absorbers is installed to reduce reflections from the ceiling.

Picture 1 of the photo documentation shows a complete view of the test environment. The system allows the measurement of SAR values larger than 0.005 mW/g.

**2.3 Data Acquisition Electronics description**

The data acquisition electronics (DAE) consist of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converte and a command decoder with a control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information, as well as an optical uplink for commands and the clock.

The mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection.

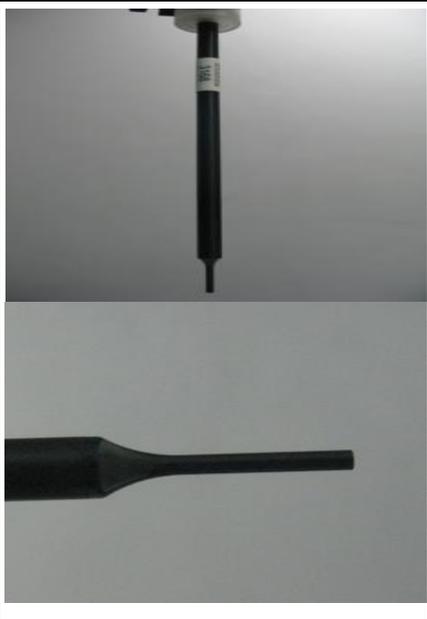
**DAE4**

|                       |                          |   |
|-----------------------|--------------------------|---|
| Input Impedance       | 200MOhm                  |  |
| The Inputs            | symmetrical and floating |   |
| Common mode rejection | above 80 dB              |   |

## 2.4 Probe description

These probes are specially designed and calibrated for use in liquids with high permittivities. They should not be used in air, since the spherical isotropy in air is poor ( $\pm 2$  dB). The dosimetric probes have special calibrations in various liquids at different frequencies.

### Isotropic E-Field Probe ES3DV3 for Dosimetric Measurements

|               |  |  |
|---------------|--|--|
| Construction  | Symmetrical design with triangular core<br>Interleaved sensors<br>Built-in shielding against static charges<br>PEEK enclosure material (resistant to organic solvents, e.g., DGBE) |  |
| Calibration   | ISO/IEC 17025 calibration service available.   |  |
| Frequency     | 10 MHz to 4 GHz; Linearity: $\pm 0.2$ dB (30 MHz to 4 GHz)   |  |
| Directivity   | $\pm 0.2$ dB in HSL (rotation around probe axis)<br>$\pm 0.3$ dB in tissue material (rotation normal to probe axis)  |  |
| Dynamic range | 5 $\mu$ W/g to > 100 mW/g; Linearity: $\pm 0.2$ dB   |  |
| Dimensions    | Overall length: 337 mm (Tip: 20 mm)<br>Tip diameter: 3.9 mm (Body: 12 mm)<br>Distance from probe tip to dipole centers: 2.0 mm   |  |
| Application   | General dosimetry up to 4 GHz<br>Dosimetry in strong gradient fields<br>Compliance tests of mobile phones  |  |

### Isotropic E-Field Probe EX3DV4 for Dosimetric Measurements

|               |  |   |
|---------------|--|---|
| Construction  | Symmetrical design with triangular core<br>Built-in shielding against static charges<br>PEEK enclosure material (resistant to organic solvents, e.g., DGBE)  |  |
| Calibration   | ISO/IEC 17025 calibration service available.   |   |
| Frequency     | 10 MHz to >6 GHz; Linearity: $\pm 0.2$ dB (30 MHz to 6 GHz)  |   |
| Directivity   | $\pm 0.3$ dB in HSL (rotation around probe axis)<br>$\pm 0.5$ dB in tissue material (rotation normal to probe axis)  |   |
| Dynamic range | 10 $\mu$ W/g to > 100 mW/g;<br>Linearity: $\pm 0.2$ dB (noise: typically < 1 $\mu$ W/g)  |   |
| Dimensions    | Overall length: 337 mm (Tip: 20 mm)<br>Tip diameter: 2.5 mm (Body: 12 mm)<br>Typical distance from probe tip to dipole centers: 1mm  |   |
| Application   | High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields).<br>Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30% |   |

## 2.5 Phantom description

### SAM Twin Phantom

|                   |  |   |
|-------------------|--|---|
| Shell Thickness   | 2mm +/- 0.2 mm; The ear region: 6mm                    |  |
| Filling Volume    | Approximately 30 liters                                |   |
| Dimensions        | Length:1000mm; Width:500mm;<br>Height: adjustable feet |   |
| Measurement Areas | Left hand<br>Right hand<br>Flat phantom                |   |

The bottom plate contains three pairs of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. A white cover is provided to cover the phantom during off-periods to prevent water evaporation and changes in the liquid parameters. Free space scans of devices on top of this phantom cover are possible. Three reference marks are provided on the phantom counter. These reference marks are used to teach the absolute phantom position relative to the robot.

### ELI4 Phantom

|                   |  |  |
|-------------------|--|--|
| Shell Thickness   | 2mm +/- 0.2 mm   |  |
| Filling Volume    | Approximately 30 liters                                |  |
| Dimensions        | Length:1000mm; Width:500mm;<br>Height: adjustable feet |  |
| Measurement Areas | Flat phantom   |  |

The ELI4 phantom is intended for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30MHz to 6GHz. ELI4 is fully compatible with the latest draft of the standard IEC 62209-2 and all known tissue simulating liquids.

## 2.6 Device holder description

The DASY5 device holder has two scales for device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear openings). The plane between the ear openings and the mouth tip has a rotation angle of 65°. The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. This device holder is used for standard mobile phones or PDA's only. If necessary an additional support of polystyrene material is used.



Larger DUT's (e.g. notebooks) cannot be tested using this device holder. Instead a support of bigger polystyrene cubes and thin polystyrene plates is used to position the DUT in all relevant positions to find and measure spots with maximum SAR values.

Therefore those devices are normally only tested at the flat part of the SAM.

## 2.7 Test Equipment List

This table gives a complete overview of the SAR measurement equipment  
 Devices used during the test described are marked

|                                     | Manufacturer  | Device                               | Type    | Serial number | Date of last calibration )* | Valid period |
|-------------------------------------|---------------|--------------------------------------|---------|---------------|-----------------------------|--------------|
| <input type="checkbox"/>            | SPEAG         | Dosimetric E-Field Probe             | EX3DV4  | 3744          | 2012-07-27                  | One year     |
| <input checked="" type="checkbox"/> | SPEAG         | Dosimetric E-Field Probe             | ES3DV3  | 3168          | 2012-10-02                  | One year     |
| <input checked="" type="checkbox"/> | SPEAG         | 835 MHz Dipole                       | D835V2  | 4d126         | 2011-11-07                  | Three years  |
| <input type="checkbox"/>            | SPEAG         | 1800 MHz Dipole                      | D1800V2 | 2d184         | 2011-03-08                  | Three years  |
| <input checked="" type="checkbox"/> | SPEAG         | 1900 MHz Dipole                      | D1900V2 | 5d143         | 2011-09-26                  | Three years  |
| <input type="checkbox"/>            | SPEAG         | 2000 MHz Dipole                      | D2000V2 | 1052          | 2011-03-10                  | Three years  |
| <input type="checkbox"/>            | SPEAG         | 2300 MHz Dipole                      | D2300V2 | 1016          | 2011-11-22                  | Three years  |
| <input type="checkbox"/>            | SPEAG         | 2450 MHz Dipole                      | D2450V2 | 860           | 2011-03-08                  | Three years  |
| <input type="checkbox"/>            | SPEAG         | 2600 MHz Dipole                      | D2600V2 | 1021          | 2011-11-22                  | Three years  |
| <input type="checkbox"/>            | SPEAG         | Data acquisition electronics         | DAE4    | 852           | 2012-11-22                  | One year     |
| <input type="checkbox"/>            | SPEAG         | Data acquisition electronics         | DAE4    | 851           | 2012-07-25                  | One year     |
| <input checked="" type="checkbox"/> | SPEAG         | Data acquisition electronics         | DAE4    | 1236          | 2012-11-23                  | One year     |
| <input checked="" type="checkbox"/> | SPEAG         | Software                             | DASY 5  | N/A           | N/A                         | N/A          |
| <input type="checkbox"/>            | SPEAG         | Twin Phantom                         | SAM1    | TP-1475       | N/A                         | N/A          |
| <input type="checkbox"/>            | SPEAG         | Twin Phantom                         | SAM2    | TP-1474       | N/A                         | N/A          |
| <input checked="" type="checkbox"/> | SPEAG         | Twin Phantom                         | SAM3    | TP-1597       | N/A                         | N/A          |
| <input checked="" type="checkbox"/> | SPEAG         | Twin Phantom                         | SAM4    | TP-1620       | N/A                         | N/A          |
| <input type="checkbox"/>            | SPEAG         | Flat Phantom                         | ELI 4.0 | TP-1038       | N/A                         | N/A          |
| <input type="checkbox"/>            | SPEAG         | Flat Phantom                         | ELI 4.0 | TP-1111       | N/A                         | N/A          |
| <input checked="" type="checkbox"/> | R & S         | Universal Radio Communication Tester | CMU 200 | 113989        | 2012-06-07                  | One year     |
| <input checked="" type="checkbox"/> | Agilent)*     | Network Analyser                     | E5071B  | MY42404956    | 2013-02-27                  | One year     |
| <input checked="" type="checkbox"/> | Agilent       | Dielectric Probe Kit                 | 85070E  | 2484          | N/A                         | N/A          |
| <input checked="" type="checkbox"/> | Agilent       | Signal Generator                     | N5181A  | MY47420989    | 2013-02-27                  | One year     |
| <input checked="" type="checkbox"/> | MINI-CIRCUITS | Amplifier                            | ZHL-42W | QA0746001     | N/A                         | N/A          |
| <input checked="" type="checkbox"/> | Agilent       | Power Meter                          | E4417A  | MY45101339    | 2013-02-26                  | One year     |
| <input checked="" type="checkbox"/> | Agilent       | Power Meter Sensor                   | E9321A  | MY44420359    | 2013-02-26                  | One year     |

Note: All the test equipments are calibrated once a year, except the dipoles, which are calibrated every three years. Moreover, we have self-calibration every year to the dipoles.

1) Per KDB 450824 D02 requirements for dipole calibration, Huawei SAR lab has adopted three years calibration interval. But each measured dipole is expected to evaluate with the following criteria at least on annual interval in Appendix C.

- a) There is no physical damage on the dipole;
- b) System check with specific dipole is within 10% of calibrated value;
- c) Return-loss is within 10% of calibrated measurement;
- d) Impedance is within 5Ω from the previous measurement.

2) Network analyzer probe calibration against air, distilled water and a shorting block performed before measuring liquid parameters.

### 3 SAR Measurement Procedure

#### 3.1 Scanning procedure

The DASY5 installation includes predefined files with recommended procedures for measurements and system check. They are read-only document files and destined as fully defined but unmeasured masks. All test positions (head or body-worn) are tested with the same configuration of test steps differing only in the grid definition for the different test positions.

- The “reference” and “drift” measurements are located at the beginning and end of the batch process. They measure the field drift at one single point in the liquid over the complete procedure. The indicated drift is mainly the variation of the DUT’s output power and should vary max. +/- 5 %.
- The “surface check” measurement tests the optical surface detection system of the DASY5 system by repeatedly detecting the surface with the optical and mechanical surface detector and comparing the results. The output gives the detecting heights of both systems, the difference between the two systems and the standard deviation of the detection repeatability. Air bubbles or refraction in the liquid due to separation of the sugar-water mixture gives poor repeatability (above  $\pm 0.1\text{mm}$ ). To prevent wrong results tests are only executed when the liquid is free of air bubbles. The difference between the optical surface detection and the actual surface depends on the probe and is specified with each probe. (It does not depend on the surface reflectivity or the probe angle to the surface within  $\pm 30^\circ$ .)
- The “area scan” measures the SAR above the DUT or verification dipole on a parallel plane to the surface. It is used to locate the approximate location of the peak SAR with 2D spline interpolation. The robot performs a stepped movement along one grid axis while the local electrical field strength is measured by the probe. The probe is touching the surface of the SAM during acquisition of measurement values. The standard scan uses large grid spacing for faster measurement. Standard grid spacing for head measurements is 15 mm in x- and y- dimension ( $\leq 2\text{GHz}$ ), 12 mm in x- and y- dimension (2-4GHz) and 10mm in x- and y- dimension (4-6GHz). If a finer resolution is needed, the grid spacing can be reduced. Grid spacing and orientation have no influence on the SAR result. For special applications where the standard scan method does not find the peak SAR within the grid, e.g. mobile phones with flip cover, the grid can be adapted in orientation. Results of this coarse scan are shown in Appendix B.
- A “zoom scan” measures the field in a volume around the 2D peak SAR value acquired in the previous “coarse” scan. This is a fine grid with maximum scan spatial resolution:  $\Delta x_{\text{zoom}}, \Delta y_{\text{zoom}} \leq 4\text{GHz} - \leq 5\text{ mm}$  and  $4-6\text{ GHz} - \leq 4\text{ mm}$ ;  $\Delta z_{\text{zoom}} \leq 3\text{GHz} - \leq 5\text{ mm}$ ,  $3-4\text{ GHz} - \leq 4\text{ mm}$  and  $4-6\text{GHz} - \leq 2\text{mm}$  where the robot additionally moves the probe along the z-axis away from the bottom of the Phantom. DASY is also able to perform repeated zoom scans if more than 1 peak is found during area scan. In this document, the evaluated peak 1g and 10g averaged SAR values are shown in the 2D-graphics in Appendix B. Test results relevant for the specified standard (see chapter 1.4.) are shown in table form form in chapter 7.2.
- A Z-axis scan measures the total SAR value at the x-and y-position of the maximum SAR value found during the cube scan. The probe is moved away in z-direction from the bottom of the SAM phantom in 2 mm steps. This measurement shows the continuity of the liquid and can - depending in the field strength – also show the liquid depth. A z-axis scan of the measurement with maximum SAR value is shown in Appendix B.

### 3.2 Spatial Peak SAR Evaluation

The spatial peak SAR - value for 1 and 10 g is evaluated after the Cube measurements have been done. The basis of the evaluation are the SAR values measured at the points of the fine cube grid consisting of 7 x 7 x 7 points. The algorithm that finds the maximal averaged volume is separated into three different stages.

- The data between the dipole center of the probe and the surface of the phantom are extrapolated. This data cannot be measured since the center of the dipole is 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is about 1 mm (see probe calibration sheet). The extrapolated data from a cube measurement can be visualized by selecting 'Graph Evaluated'.
- The maximum interpolated value is searched with a straight-forward algorithm. Around this maximum the SAR - values averaged over the spatial volumes (1g or 10 g) are computed using the 3d-spline interpolation algorithm. If the volume cannot be evaluated (i.e., if a part of the grid was cut off by the boundary of the measurement area) the evaluation will be started on the corners of the bottom plane of the cube.
- All neighboring volumes are evaluated until no neighboring volume with a higher average value is found.

#### Extrapolation

The extrapolation is based on a least square algorithm [W. Gander, Computermathematik, p.168-180]. Through the points in the first 3 cm along the z-axis, polynomials of order four are calculated. These polynomials are then used to evaluate the points between the surface and the probe tip. The points, calculated from the surface, have a distance of 1 mm from each other.

#### Interpolation

The interpolation of the points is done with a 3d-Spline. The 3d-Spline is composed of three one-dimensional splines with the "Not a knot"-condition [W. Gander, Computermathematik, p.141-150] (x, y and z -direction) [Numerical Recipes in C, Second Edition, p.123ff].

#### Volume Averaging

At First the size of the cube is calculated. Then the volume is integrated with the trapezoidal algorithm. 8000 points (20x20x20) are interpolated to calculate the average.

#### Advanced Extrapolation

DASY5 uses the advanced extrapolation option which is able to compensate boundary effects on E-field probes.

### 3.3 Data Storage and Evaluation

#### Data Storage

The DASY5 software stores the acquired data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files with the extension DAE4. The software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of incorrect parameter settings. For example, if a measurement has been performed with a wrong crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be re-evaluated.

The measured data can be visualized or exported in different units or formats, depending on the selected probe type ([V/m], [A/m], [°C], [mW/g], [mW/cm<sup>2</sup>], [dBrel], etc.). Some of these units are not available in certain situations or show meaningless results, e.g., a SAR output in a lossless media will always be zero. Raw data can also be exported to perform the evaluation with other software packages.

#### Data Evaluation by SEMCAD

The SEMCAD software automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

|                    |                           |   |
|--------------------|---------------------------|---|
| Probe parameters:  | - Sensitivity             | Norm <sub>i</sub> , a <sub>10</sub> , a <sub>11</sub> , a <sub>12</sub> |
|                    | - Conversion factor       | ConvF <sub>i</sub>  |
|                    | - Diode compression point | Dcpi  |
| Device parameters: | - Frequency               | f   |
|                    | - Crest factor            | cf  |
| Media parameters:  | - Conductivity            | σ   |
|                    | - Density                 | ρ   |

These parameters must be set correctly in the software. They can be found in the component documents or they can be imported into the software from the configuration files issued for the DASY5 components. In the direct measuring mode of the multimeter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics.

If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as:

$$V_i = U_i + U_i^2 \cdot cf/dcp_i$$

|      |                  |   |                  |
|------|------------------|---|------------------|
| with | V <sub>i</sub>   | = compensated signal of channel i                 | (i = x, y, z)    |
|      | U <sub>i</sub>   | = input signal of channel i                       | (i = x, y, z)    |
|      | cf               | = crest factor of exciting field (DASY parameter) |                  |
|      | dcp <sub>i</sub> | = diode compression point                         | (DASY parameter) |

From the compensated input signals the primary field data for each channel can be evaluated:

E-field probes:  $E_i = (V_i / Norm_i \cdot ConvF)^{1/2}$   
H-field probes:  $H_i = (V_i)^{1/2} \cdot (a_{i0} + a_{i1}f + a_{i2}f^2)/f$

- with  $V_i$  = compensated signal of channel i (i = x, y, z)  
 $Norm_i$  = sensor sensitivity of channel i (i = x, y, z)  
[mV/(V/m)<sup>2</sup>] for E-field Probes  
ConvF = sensitivity enhancement in solution  
 $a_{ij}$  = sensor sensitivity factors for H-field probes  
f = carrier frequency [GHz]  
 $E_i$  = electric field strength of channel i in V/m  
 $H_i$  = magnetic field strength of channel i in A/m

The RSS value of the field components gives the total field strength (Hermitian magnitude):

$$E_{tot} = (E_x^2 + E_y^2 + E_z^2)^{1/2}$$

The primary field data are used to calculate the derived field units.

$$SAR = (E_{tot}^2 \cdot \sigma) / (\rho \cdot 1000)$$

- with SAR = local specific absorption rate in mW/g  
 $E_{tot}$  = total field strength in V/m  
 $\sigma$  = conductivity in [mho/m] or [Siemens/m]  
 $\rho$  = equivalent tissue density in g/cm<sup>3</sup>

Note that the density is normally set to 1 (or 1.06), to account for actual brain density rather than the density of the simulation liquid. The power flow density is calculated assuming the excitation field to be a free space field.

$$P_{pwe} = E_{tot}^2 / 3770 \quad \text{or} \quad P_{pwe} = H_{tot}^2 \cdot 37.7$$

- with  $P_{pwe}$  = equivalent power density of a plane wave in mW/cm<sup>2</sup>  
 $E_{tot}$  = total electric field strength in V/m  
 $H_{tot}$  = total magnetic field strength in A/m

## 4 System Verification Procedure

### 4.1 Tissue Verification

The simulating liquids should be checked at the beginning of a series of SAR measurements to determine if the dielectric parameters are within the tolerances of the specified target values. The measured conductivity and relative permittivity should be within  $\pm 5\%$  of the target values.

The following materials are used for producing the tissue-equivalent materials.

| Ingredients (% of weight) | Body Tissue |      |       |       |       |      |
|---------------------------|-------------|------|-------|-------|-------|------|
|                           | 450         | 835  | 900   | 1800  | 1900  | 2450 |
| Frequency Band (MHz)      | 450         | 835  | 900   | 1800  | 1900  | 2450 |
| Water                     | 51.16       | 52.4 | 56.0  | 69.91 | 69.91 | 73.2 |
| Salt (NaCl)               | 1.49        | 1.40 | 0.76  | 0.13  | 0.13  | 0.04 |
| Sugar                     | 46.78       | 45.0 | 41.76 | 0.0   | 0.0   | 0.0  |
| HEC                       | 0.52        | 1.0  | 1.21  | 0.0   | 0.0   | 0.0  |
| Bactericide               | 0.05        | 0.1  | 0.27  | 0.0   | 0.0   | 0.0  |
| Triton X-100              | 0.0         | 0.0  | 0.0   | 0.0   | 0.0   | 0.0  |
| DGBE                      | 0.0         | 0.0  | 0.0   | 29.96 | 29.96 | 26.7 |

Table 4: Tissue Dielectric Properties

Salt: 99+% Pure Sodium Chloride; Sugar: 98+% Pure Sucrose; Water: De-ionized, 16M $\Omega$ + resistivity  
 HEC: Hydroxyethyl Cellulose; DGBE: 99+% Di(ethylene glycol) butyl ether, [2-(2-butoxyethoxy)ethanol]  
 Triton X-100(ultra pure): Polyethylene glycol mono [4-(1,1,3,3-tetramethylbutyl)phenyl]ether

| Tissue Type | Measured Frequency (MHz) | Target Tissue          |                        | Measured Tissue |                | Liquid Temp. | Test Date |
|-------------|--------------------------|------------------------|------------------------|-----------------|----------------|--------------|-----------|
|             |                          | $\epsilon_r$ (+/-5%)   | $\sigma$ (S/m) (+/-5%) | $\epsilon_r$    | $\sigma$ (S/m) |              |           |
| 835B        | 825                      | 55.20<br>(52.44~57.96) | 0.97<br>(0.92~1.02)    | 56.71           | 0.978          | 21.4°C       | 2013/4/28 |
|             | 835                      | 55.20<br>(52.44~57.96) | 0.97<br>(0.92~1.02)    | 56.53           | 0.991          |              |           |
|             | 850                      | 55.20<br>(52.44~57.96) | 0.99<br>(0.94~1.04)    | 56.44           | 1.009          |              |           |
| 1900B       | 1850                     | 53.30<br>(50.64~55.97) | 1.52<br>(1.44~1.60)    | 53.28           | 1.475          | 21.4°C       | 2013/5/2  |
|             | 1880                     | 53.30<br>(50.64~55.97) | 1.52<br>(1.44~1.60)    | 53.36           | 1.516          |              |           |
|             | 1900                     | 53.30<br>(50.64~55.97) | 1.52<br>(1.44~1.60)    | 53.09           | 1.532          |              |           |
|             | 1910                     | 53.30<br>(50.64~55.97) | 1.52<br>(1.44~1.60)    | 53.06           | 1.546          |              |           |

$\epsilon_r$ = Relative permittivity,  $\sigma$ = Conductivity

Table 5: Measured Tissue Parameter

Note: 1) The dielectric parameters of the tissue-equivalent liquid should be measured under similar ambient conditions and within 2 °C of the conditions expected during the SAR evaluation to satisfy protocol requirements.

2) KDB 450824 was ensured to be applied for probe calibration frequencies greater than or equal to 50MHz of the EUT frequencies.

3) The above measured tissue parameters were used in the DASY software to perform interpolation via the DASY software to determine actual dielectric parameters at the test frequencies. The SAR test plots may slightly differ from the table above since the DASY rounds to three significant digits.

### 4.2 System Check

The system check is performed for verifying the accuracy of the complete measurement system and performance of the software. The system check is performed with tissue equivalent material according to IEEE P1528 (described above). The following table shows system check results for all frequency bands and tissue liquids used during the tests (Graphic Plot(s) see Appendix A).

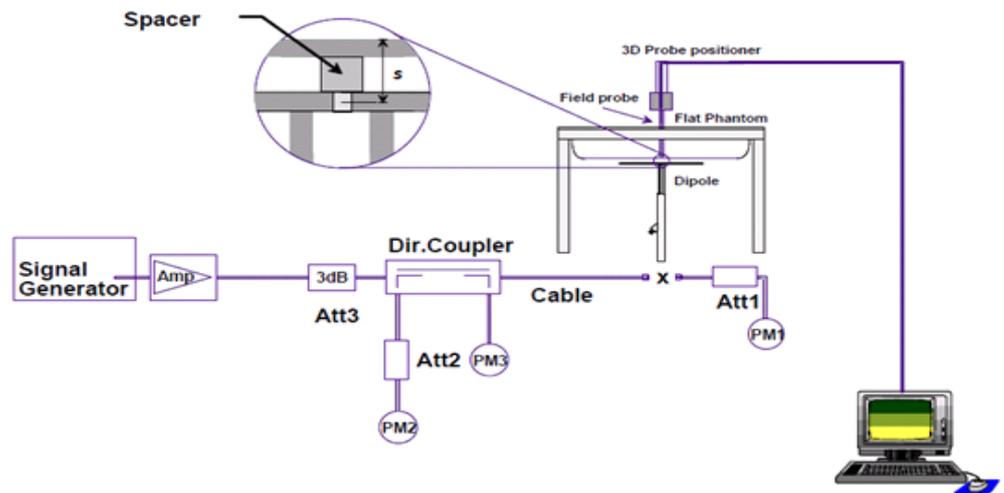
| System Check | Target SAR (1W) (+/-10%) |                        | Measured SAR (Normalized to 1W) |             | Liquid Temp. | Test Date |
|--------------|--------------------------|------------------------|---------------------------------|-------------|--------------|-----------|
|              | 1-g (mW/g)               | 10-g (mW/g)            | 1-g (mW/g)                      | 10-g (mW/g) |              |           |
| D835V2 Body  | 9.54<br>(8.59~10.49)     | 6.29<br>(5.66~6.92)    | 10.04                           | 6.76        | 21.4°C       | 2013/4/28 |
| D1900V2 Body | 41.40<br>(37.26~45.54)   | 21.80<br>(19.62~23.98) | 41.20                           | 21.36       | 21.4°C       | 2013/5/2  |

Table 6: System Check Results

### 4.3 System check Procedure

The system check is performed by using a system check dipole which is positioned parallel to the planar part of the SAM phantom at the reference point. The distance of the dipole to the SAM phantom is determined by a plexiglass spacer. The dipole is connected to the signal source consisting of signal generator and amplifier via a directional coupler, N-connector cable and adaption to SMA. It is fed with a power of 250 mW. To adjust this power a power meter is used. The power sensor is connected to the cable before the system check to measure the power at this point and do adjustments at the signal generator. At the outputs of the directional coupler both return loss as well as forward power are controlled during the system check to make sure that emitted power at the dipole is kept constant. This can also be checked by the power drift measurement after the test (result on plot).

System check results have to be equal or near the values determined during dipole calibration (target SAR in table above) with the relevant liquids and test system.



## 5 Measurement Uncertainty Evaluation

### 5.1 Measurement uncertainty evaluation for SAR test

The overall combined measurement uncertainty of the measurement system is  $\pm 10.9\%$  ( $K=1$ ).

The expanded uncertainty ( $k=2$ ) is assessed to be  $\pm 21.9\%$

This measurement uncertainty budget is suggested by IEEE P1528 and determined by Schmid & Partner Engineering AG. The breakdown of the individual uncertainties is as follows:

| Error Sources                    | Uncertainty Value                    | Probability Distribution | Divisor    | $c_i$ 1g | $c_i$ 10g | Standard Uncertainty y 1g | Standard Uncertainty y10g | $v_i^2$ or $v_{eff}$ |
|----------------------------------|--------------------------------------|--------------------------|------------|----------|-----------|---------------------------|---------------------------|----------------------|
| <b>Measurement System</b>        |                                      |                          |            |          |           |                           |                           |                      |
| Probe calibration                | $\pm 6.0\%$                          | Normal                   | 1          | 1        | 1         | $\pm 6.0\%$               | $\pm 6.0\%$               | $\infty$             |
| Axial isotropy                   | $\pm 4.7\%$                          | Rectangular              | $\sqrt{3}$ | 0.7      | 0.7       | $\pm 1.9\%$               | $\pm 1.9\%$               | $\infty$             |
| Hemispherical isotropy           | $\pm 9.6\%$                          | Rectangular              | $\sqrt{3}$ | 0.7      | 0.7       | $\pm 3.9\%$               | $\pm 3.9\%$               | $\infty$             |
| Spatial resolution               | $\pm 0.0\%$                          | Rectangular              | $\sqrt{3}$ | 1        | 1         | $\pm 0.0\%$               | $\pm 0.0\%$               | $\infty$             |
| Boundary effects                 | $\pm 1.0\%$                          | Rectangular              | $\sqrt{3}$ | 1        | 1         | $\pm 0.6\%$               | $\pm 0.6\%$               | $\infty$             |
| Probe linearity                  | $\pm 4.7\%$                          | Rectangular              | $\sqrt{3}$ | 1        | 1         | $\pm 2.7\%$               | $\pm 2.7\%$               | $\infty$             |
| System detection limits          | $\pm 1.0\%$                          | Rectangular              | $\sqrt{3}$ | 1        | 1         | $\pm 0.6\%$               | $\pm 0.6\%$               | $\infty$             |
| Readout electronics              | $\pm 0.3\%$                          | Normal                   | 1          | 1        | 1         | $\pm 0.3\%$               | $\pm 0.3\%$               | $\infty$             |
| Response time                    | $\pm 0.8\%$                          | Rectangular              | $\sqrt{3}$ | 1        | 1         | $\pm 0.5\%$               | $\pm 0.5\%$               | $\infty$             |
| Integration time                 | $\pm 2.6\%$                          | Rectangular              | $\sqrt{3}$ | 1        | 1         | $\pm 1.5\%$               | $\pm 1.5\%$               | $\infty$             |
| RF ambient conditions            | $\pm 3.0\%$                          | Rectangular              | $\sqrt{3}$ | 1        | 1         | $\pm 1.7\%$               | $\pm 1.7\%$               | $\infty$             |
| Probe positioner                 | $\pm 0.4\%$                          | Rectangular              | $\sqrt{3}$ | 1        | 1         | $\pm 0.2\%$               | $\pm 0.2\%$               | $\infty$             |
| Probe positioning                | $\pm 2.9\%$                          | Rectangular              | $\sqrt{3}$ | 1        | 1         | $\pm 1.7\%$               | $\pm 1.7\%$               | $\infty$             |
| Max. SAR evaluation              | $\pm 1.0\%$                          | Rectangular              | $\sqrt{3}$ | 1        | 1         | $\pm 0.6\%$               | $\pm 0.6\%$               | $\infty$             |
| <b>Test Sample Related</b>       |                                      |                          |            |          |           |                           |                           |                      |
| Device positioning               | $\pm 2.9\%$                          | Normal                   | 1          | 1        | 1         | $\pm 2.9\%$               | $\pm 2.9\%$               | 145                  |
| Device holder uncertainty        | $\pm 3.6\%$                          | Normal                   | 1          | 1        | 1         | $\pm 3.6\%$               | $\pm 3.6\%$               | 5                    |
| Power drift                      | $\pm 5.0\%$                          | Rectangular              | $\sqrt{3}$ | 1        | 1         | $\pm 2.9\%$               | $\pm 2.9\%$               | $\infty$             |
| <b>Phantom and Set-up</b>        |                                      |                          |            |          |           |                           |                           |                      |
| Phantom uncertainty              | $\pm 4.0\%$                          | Rectangular              | $\sqrt{3}$ | 1        | 1         | $\pm 2.3\%$               | $\pm 2.3\%$               | $\infty$             |
| Liquid conductivity (target)     | $\pm 5.0\%$                          | Rectangular              | $\sqrt{3}$ | 0.64     | 0.43      | $\pm 1.8\%$               | $\pm 1.2\%$               | $\infty$             |
| Liquid conductivity (meas.)      | $\pm 2.5\%$                          | Normal                   | 1          | 0.64     | 0.43      | $\pm 1.6\%$               | $\pm 1.1\%$               | $\infty$             |
| Liquid permittivity (target)     | $\pm 5.0\%$                          | Rectangular              | $\sqrt{3}$ | 0.6      | 0.49      | $\pm 1.7\%$               | $\pm 1.4\%$               | $\infty$             |
| Liquid permittivity (meas.)      | $\pm 2.5\%$                          | Normal                   | 1          | 0.6      | 0.49      | $\pm 1.5\%$               | $\pm 1.2\%$               | $\infty$             |
| <b>Combined Uncertainty</b>      | $u_c = \sqrt{\sum_{i=1}^{21} u_i^2}$ |                          |            |          |           | $\pm 10.9\%$              | $\pm 10.7\%$              | 387                  |
| <b>Expanded Std. Uncertainty</b> | $u_e = 2u_c$                         | Normal                   | <b>K=2</b> |          |           | $\pm 21.9\%$              | $\pm 21.4\%$              |                      |

Table 7: Measurement uncertainties

## 5.2 Measurement uncertainty evaluation for system check

The overall combined measurement uncertainty of the measurement system is  $\pm 9.5\%$  ( $K=1$ ).

The expanded uncertainty ( $k=2$ ) is assessed to be  $\pm 18.9\%$

This measurement uncertainty budget is suggested by IEEE P1528 and determined by Schmid & Partner Engineering AG. The breakdown of the individual uncertainties is as follows:

| Error Sources                    | Uncertainty Value                    | Probability Distribution | Divisor    | $c_i$ 1g | $c_i$ 10g | Standard Uncertainty y 1g      | Standard Uncertainty y10g      | $v_i^2$ or $v_{eff}$ |
|----------------------------------|--------------------------------------|--------------------------|------------|----------|-----------|--------------------------------|--------------------------------|----------------------|
| <b>Measurement System</b>        |                                      |                          |            |          |           |                                |                                |                      |
| Probe calibration                | $\pm 6.0\%$                          | Normal                   | 1          | 1        | 1         | $\pm 6.0\%$                    | $\pm 6.0\%$                    | $\infty$             |
| Axial isotropy                   | $\pm 4.7\%$                          | Rectangular              | $\sqrt{3}$ | 1        | 1         | $\pm 2.7\%$                    | $\pm 2.7\%$                    | $\infty$             |
| Hemispherical isotropy           | $\pm 9.6\%$                          | Rectangular              | $\sqrt{3}$ | 0.7      | 0.7       | $\pm 0.0\%$                    | $\pm 0.0\%$                    | $\infty$             |
| Boundary effects                 | $\pm 1.0\%$                          | Rectangular              | $\sqrt{3}$ | 1        | 1         | $\pm 0.6\%$                    | $\pm 0.6\%$                    | $\infty$             |
| Probe linearity                  | $\pm 4.7\%$                          | Rectangular              | $\sqrt{3}$ | 1        | 1         | $\pm 2.7\%$                    | $\pm 2.7\%$                    | $\infty$             |
| System detection limits          | $\pm 1.0\%$                          | Rectangular              | $\sqrt{3}$ | 1        | 1         | $\pm 0.6\%$                    | $\pm 0.6\%$                    | $\infty$             |
| Readout electronics              | $\pm 0.3\%$                          | Normal                   | 1          | 1        | 1         | $\pm 0.3\%$                    | $\pm 0.3\%$                    | $\infty$             |
| Response time                    | $\pm 0.0\%$                          | Rectangular              | $\sqrt{3}$ | 1        | 1         | $\pm 0.0\%$                    | $\pm 0.0\%$                    | $\infty$             |
| Integration time                 | $\pm 0.0\%$                          | Rectangular              | $\sqrt{3}$ | 1        | 1         | $\pm 0.0\%$                    | $\pm 0.0\%$                    | $\infty$             |
| RF ambient conditions            | $\pm 1.0\%$                          | Rectangular              | $\sqrt{3}$ | 1        | 1         | $\pm 0.6\%$                    | $\pm 0.6\%$                    | $\infty$             |
| Probe positioner                 | $\pm 0.4\%$                          | Rectangular              | $\sqrt{3}$ | 1        | 1         | $\pm 0.2\%$                    | $\pm 0.2\%$                    | $\infty$             |
| Probe positioning                | $\pm 2.9\%$                          | Rectangular              | $\sqrt{3}$ | 1        | 1         | $\pm 1.7\%$                    | $\pm 1.7\%$                    | $\infty$             |
| Max. SAR evaluation              | $\pm 1.0\%$                          | Rectangular              | $\sqrt{3}$ | 1        | 1         | $\pm 0.6\%$                    | $\pm 0.6\%$                    | $\infty$             |
| <b>Dipole</b>                    |                                      |                          |            |          |           |                                |                                |                      |
| Deviation of experimental dipole | $\pm 5.5\%$                          | Rectangular              | $\sqrt{3}$ | 1        | 1         | $\pm 3.2\%$                    | $\pm 3.2\%$                    | $\infty$             |
| Dipole axis to liquid distance   | $\pm 2.0\%$                          | Rectangular              | 1          | 1        | 1         | $\pm 1.2\%$                    | $\pm 1.2\%$                    | $\infty$             |
| Power drift                      | $\pm 4.7\%$                          | Rectangular              | $\sqrt{3}$ | 1        | 1         | $\pm 2.7\%$                    | $\pm 2.7\%$                    | $\infty$             |
| <b>Phantom and Set-up</b>        |                                      |                          |            |          |           |                                |                                |                      |
| Phantom uncertainty              | $\pm 4.0\%$                          | Rectangular              | $\sqrt{3}$ | 1        | 1         | $\pm 2.3\%$                    | $\pm 2.3\%$                    | $\infty$             |
| Liquid conductivity (target)     | $\pm 5.0\%$                          | Rectangular              | $\sqrt{3}$ | 0.64     | 0.43      | $\pm 1.8\%$                    | $\pm 1.2\%$                    | $\infty$             |
| Liquid conductivity (meas.)      | $\pm 2.5\%$                          | Normal                   | 1          | 0.64     | 0.43      | $\pm 1.6\%$                    | $\pm 1.1\%$                    | $\infty$             |
| Liquid permittivity (target)     | $\pm 5.0\%$                          | Rectangular              | $\sqrt{3}$ | 0.6      | 0.49      | $\pm 1.7\%$                    | $\pm 1.4\%$                    | $\infty$             |
| Liquid permittivity (meas.)      | $\pm 2.5\%$                          | Normal                   | 1          | 0.6      | 0.49      | $\pm 1.5\%$                    | $\pm 1.2\%$                    | $\infty$             |
| <b>Combined Uncertainty</b>      | $u_c = \sqrt{\sum_{i=1}^{21} u_i^2}$ |                          |            |          |           | <b><math>\pm 9.5\%</math></b>  | <b><math>\pm 9.2\%</math></b>  |                      |
| <b>Expanded Std. Uncertainty</b> | $u_e = 2u_c$                         | Normal                   | <b>K=2</b> |          |           | <b><math>\pm 18.9\%</math></b> | <b><math>\pm 18.4\%</math></b> |                      |

Table 8: Measurement uncertainties

## 6 SAR Test Configuration

### 6.1 GSM Test Configuration

SAR tests for GSM850 and GSM1900, a communication link is set up with a base station by air link. The tests in the band of GSM850 and GSM1900 are performed in the mode of GPRS/EGPRS function. Since the GPRS class is 12 for this EUT, it has at most 4 timeslots in uplink and at most 4 timeslots in downlink, the maximum total timeslot is 5. The EGPRS class is 12 for this EUT, it has at most 4 timeslots in uplink, and at most 4 timeslots in downlink, the maximum total timeslot is 5.

When SAR tests for EGPRS mode is necessary, GMSK modulation should be used to minimize SAR measurement error due to higher peak-to-average power (PAR) ratios inherent in 8-PSK.

According to specification 3GPP TS 51.010, the maximum power of the GSM can do the power reduction for the multi-slot.

The allowed power reduction in the multi-slot configuration is as following:

| Number of timeslots in uplink assignment |            | Reduction of maximum output power, (dB) |              |              |
|--|------------|---|--------------|--------------|
| Band                                     | Time Slots | GPRS (GMSK)                             | EGPRS (GMSK) | EGPRS (8PSK) |
| GSM850                                   | 1 TX slot  | 0                                       | 0            | 0            |
|  | 2 TX slots | 1                                       | 1            | 0.5          |
|  | 3 TX slots | 3                                       | 3            | 2.3          |
|  | 4 TX slots | 5                                       | 5            | 4.3          |
| GSM1900                                  | 1 TX slot  | 0                                       | 0            | 0            |
|  | 2 TX slots | 1                                       | 1            | 0.5          |
|  | 3 TX slots | 3                                       | 3            | 2.5          |
|  | 4 TX slots | 5                                       | 5            | 4.5          |

Table 9: The allowed power reduction in the multi-slot configuration of GSM

## 6.2 UMTS Test Configuration

### 1) RMC

As the SAR body tests for UMTS Band II, we established the radio link through call processing. The maximum output power were verified on high, middle and low channels for each test band according to 3GPP TS 34.121 with the following configuration:

- 1) 12.2kbps RMC, 64,144,384 kbps RMC with TPC set to 'all 1'.
- 2) Test loop Mode 1.

For the output power, the configurations for the DPCCH and DPDCH<sub>1</sub> are as followed (EUT do not support the DPDCH<sub>2-n</sub>)

|                    | Channel Bit Rate (kbps) | Channel Symbol Rate (ksps) | Spreading Factor | Spreading Code Number | Bits/Slot |
|--------------------|-------------------------|----------------------------|------------------|-----------------------|-----------|
| DPCCH              | 15                      | 15                         | 256              | 0                     | 10        |
| DPDCH <sub>1</sub> | 15                      | 15                         | 256              | 64                    | 10        |
|                    | 30                      | 30                         | 128              | 32                    | 20        |
|                    | 60                      | 60                         | 64               | 16                    | 40        |
|                    | 120                     | 120                        | 32               | 8                     | 80        |
|                    | 240                     | 240                        | 16               | 4                     | 160       |
|                    | 480                     | 480                        | 8                | 2                     | 320       |
| 960                | 960                     | 4                          | 1                | 640                   |           |
| DPDCH <sub>n</sub> | 960                     | 960                        | 4                | 1, 2, 3               | 640       |

SAR for body exposure configurations is measured using the 12.2 kbps RMC with the TPC bits configured to all "1s". SAR for other spreading codes and multiple DPDCH<sub>n</sub>, when supported by the EUT, are not required when the maximum average outputs of each RF channel, for each spreading code and DPDCH<sub>n</sub> configuration, are less than ¼ dB higher than those measured in 12.2 kbps RMC.

### 2) HSDPA

SAR for body exposure configurations is measured according to the "Body SAR Measurements" procedures of 3G device. In addition, body SAR is also measured for HSDPA when the maximum average outputs of each RF channel with HSDPA active is at ¼ dB higher than that measured without HSDPA using 12.2kbps RMC or the maximum SAR 12.2kbps RMC is above 75% of the SAR limit. Body SAR for HSDPA is measured using an FRC with H-Set 1 in Sub-test 1 and a 12.2kbps RMC configured in Test Loop Mode 1, using the highest body SAR configuration in 12.2 kbps RMC without HSDPA.

HSDPA should be configured according to UE category of a test device. The number of HS-DSCH/HS-PDSCHs, HAPRQ processes, minimum inter-TTI interval, transport block sizes and RV coding sequence are defined by the H-set. To maintain a consistent test configuration and stable transmission condition, QPSK is used in the H-set for SAR testing. HS-DPCCH should be configured with a CQI feedback cycle of 4ms with a CQI repetition factor of 2 to maintain a constant rate of active CQI slots. The  $\beta_c$  and  $\beta_d$  gain factors for DPCCH and DPDCH were set according to the values in the below table,  $\beta_{hs}$  for HS-DPCCH is set automatically to the correct value when  $\Delta ACK, \Delta NACK, \Delta CQI = 8$ . The variation of the  $\beta_c / \beta_d$  ratio causes a power reduction at sub-tests 2 - 4.

| Sub-test | $\beta_c$ | $\beta_d$ | $\beta_d$ (SF) | $\beta_c / \beta_d$ | $\beta_{hs}$ (1) | CM(dB)(2) | MPR (dB) |
|----------|-----------|-----------|----------------|---------------------|------------------|-----------|----------|
| 1        | 2/15      | 15/15     | 64             | 2/15                | 4/15             | 0.0       | 0        |
| 2        | 12/15(3)  | 15/15(3)  | 64             | 12/15(3)            | 24/15            | 1.0       | 0        |
| 3        | 15/15     | 8/15      | 64             | 15/8                | 30/15            | 1.5       | 0.5      |
| 4        | 15/15     | 4/15      | 64             | 15/4                | 30/15            | 1.5       | 0.5      |

Note 1:  $\Delta$  ACK,  $\Delta$  NACK and  $\Delta$  CQI = 8 .  $A_{hs} = \beta_{hs}/\beta_c = 30/15$  .  $\beta_{hs} = 30/15 * \beta_c$

Note 2 : CM=1 for  $\beta_c/\beta_d= 12/15$ ,  $\beta_{hs}/\beta_c = 24/15$ . For all other combinations of DPDCH,DPCCH and HS-DPCCH the MPR is based on the relative CM difference. This is applicable for only UEs that support HSDPA in release 6 and later releases.

Note 3 : For subtest 2 the  $\beta_c/\beta_d$  ratio of 12/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signalled gain factors for the reference TFC (TF1,TF1) to  $\beta_c = 11/15$  and  $\beta_d = 15/15$

Table 10: Sub-tests for UMTS Release 5 HSDPA

The measurements were performed with a Fixed Reference Channel (FRC) and H-Set 1 QPSK.

| Parameter                        | Value       |
|----------------------------------|-------------|
| Nominal average inf. bit rate    | 534 kbit/s  |
| Inter-TTI Distance               | 3 TTI's     |
| Number of HARQ Processes         | 2 Processes |
| Information Bit Payload          | 3202 Bits   |
| MAC-d PDU size                   | 336 Bits    |
| Number Code Blocks               | 1 Block     |
| Binary Channel Bits Per TTI      | 4800 Bits   |
| Total Available SMLs in UE       | 19200 SMLs  |
| Number of SMLs per HARQ Process  | 9600 SMLs   |
| Coding Rate                      | 0.67        |
| Number of Physical Channel Codes | 5           |

Table 11: settings of required H-Set 1 QPSK acc. to 3GPP 34.121

| HS-DSCH Category | Maximum HS-DSCH Codes Received | Minimum Inter-TTI Interval | Maximum HS-DSCH Transport Block Bits/HS-DSCH TTI | Total Soft Channel Bits |
|------------------|--------------------------------|----------------------------|--|-------------------------|
| 1                | 5                              | 3                          | 7298   | 19200                   |
| 2                | 5                              | 3                          | 7298   | 28800                   |
| 3                | 5                              | 2                          | 7298   | 28800                   |
| 4                | 5                              | 2                          | 7298   | 38400                   |
| 5                | 5                              | 1                          | 7298   | 57600                   |
| 6                | 5                              | 1                          | 7298   | 67200                   |
| 7                | 10                             | 1                          | 14411  | 115200                  |
| 8                | 10                             | 1                          | 14411  | 134400                  |
| 9                | 15                             | 1                          | 25251  | 172800                  |
| 10               | 15                             | 1                          | 27952  | 172800                  |
| 11               | 5                              | 2                          | 3630   | 14400                   |
| 12               | 5                              | 1                          | 3630   | 28800                   |
| 13               | 15                             | 1                          | 34800  | 259200                  |
| 14               | 15                             | 1                          | 42196  | 259200                  |
| 15               | 15                             | 1                          | 23370  | 345600                  |
| 16               | 15                             | 1                          | 27952  | 345600                  |

Table 12:HSDPA UE category

### 3) HSUPA

Body SAR is also measured for HSPA when the maximum average outputs of each RF channel with HSPA active is at  $\frac{1}{4}$  dB higher than that measured without HSPA using 12.2kbps RMC or the maximum SAR 12.2kbps RMC is above 75% of the SAR limit. Body SAR for HSPA is measured with E-DCH Sub-test 5, using H-set 1 and QPSK for FRC and 12.2kbps RMC configured in Test Loop Mode 1 with power control algorithm 2, according to the highest body SAR configuration in 12.2 kbps RMC without HSPA.

Due to inner loop power control requirements in HSPA, a commercial communication test set should be used for the output power and SAR tests. The 12.2 kbps RMC, FRC H-set 1 and E-DCH configurations for HSPA should be configured according to the values indicated below as well as other applicable procedures described in the 'WCDMA Handset' and 'Release 5 HSPA Data Device' sections of 3G device.

| Sub - test | $\beta_{c\Delta}$    | $\beta_{d\Delta}$    | $\beta_{d\Delta}$ (SF) | $\beta_{c\Delta}/\beta_{d\Delta}$ | $\beta_{hs\Delta}$ (1) | $\beta_{ec\Delta}$ | $\beta_{ed\Delta}$                         | $\beta_{ec\Delta}$ (S F) | $\beta_{ed\Delta}$ (code) | CM (2) (dB) | MP R (dB) | AG (4) (Index) | E-TFC I |
|------------|----------------------|----------------------|------------------------|-----------------------------------|------------------------|--------------------|--|--------------------------|---------------------------|-------------|-----------|----------------|---------|
| 1          | 11/15 <sup>(3)</sup> | 15/15 <sup>(3)</sup> | 64                     | 11/15 <sup>(3)</sup>              | 22/15                  | 209/25             | 1039/25                                    | 4                        | 1                         | 1.0         | 0.0       | 20             | 75      |
| 2          | 6/15                 | 15/15                | 64                     | 6/15                              | 12/15                  | 12/15              | 94/75                                      | 4                        | 1                         | 3.0         | 2.0       | 12             | 67      |
| 3          | 15/15                | 9/15                 | 64                     | 15/9                              | 30/15                  | 30/15              | $\beta_{ed1}:47/15$<br>$\beta_{ed2}:47/15$ | 4                        | 2                         | 2.0         | 1.0       | 15             | 92      |
| 4          | 2/15                 | 15/15                | 64                     | 2/15                              | 4/15                   | 2/15               | 56/75                                      | 4                        | 1                         | 3.0         | 2.0       | 17             | 71      |
| 5          | 15/15 <sup>(4)</sup> | 15/15 <sup>(4)</sup> | 64                     | 15/15 <sup>(4)</sup>              | 30/15                  | 24/15              | 134/15                                     | 4                        | 1                         | 1.0         | 0.0       | 21             | 81      |

Note 1:  $\Delta ACK, \Delta NACK$  and  $\Delta CQI = 8$ .  $A_{hs} = \beta_{hs}/\beta_c = 30/15$ .  $\beta_{hs} = 30/15 * \beta_c$

Note 2: CM = 1 for  $\beta_c/\beta_d = 12/15$ ,  $\beta_{hs}/\beta_c = 24/15$ . For all other combinations of DPDCH, DPCCH, HS-DPCCH, E-DPDCH and E-DPCCH the MPR is based on the relative CM difference

Note 3 : For subtest 1 the  $\beta_c/\beta_d$  ratio of 11/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signalled gain factors for the reference TFC (TF1, TF1) to  $\beta_c = 10/15$  and  $\beta_d = 15/15$

Note 4 : For subtest 5 the  $\beta_c/\beta_d$  ratio of 15/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signalled gain factors for the reference TFC (TF1, TF1) to  $\beta_c = 14/15$  and  $\beta_d = 15/15$

Note 5 : Testing UE using E-DPDCH Physical Layer category 1 Sub-test 3 is not required according to TS 25.306 Table 5.1g

Note 6:  $\beta_{ed}$  can not be set directly; it is set by Absolute Grant Value.

Table 13:Subtests for UMTS Release 6 HSUPA

| UE E-DCH Category | Maximum E-DCH Codes Transmitted | Number of HARQ Processes | E-DCH TTI(ms) | Minimum Spreading Factor | Maximum E-DCH Transport Block Bits | Max Rate (Mbps) |
|-------------------|---------------------------------|--------------------------|---------------|--------------------------|------------------------------------|-----------------|
| 1                 | 1                               | 4                        | 10            | 4                        | 7110                               | 0.7296          |
| 2                 | 2                               | 8                        | 2             | 4                        | 2798                               | 1.4592          |
|                   | 2                               | 4                        | 10            | 4                        | 14484                              |                 |
| 3                 | 2                               | 4                        | 10            | 4                        | 14484                              | 1.4592          |
| 4                 | 2                               | 8                        | 2             | 2                        | 5772                               | 2.9185          |
|                   | 2                               | 4                        | 10            | 2                        | 20000                              | 2.00            |
| 5                 | 2                               | 4                        | 10            | 2                        | 20000                              | 2.00            |
| 6 (No DPDCH)      | 4                               | 8                        | 10            | 2SF2&2SF                 | 11484                              | 5.76            |
|                   | 4                               | 4                        | 2             | 4                        | 20000                              | 2.00            |
| 7 (No DPDCH)      | 4                               | 8                        | 2             | 2SF2&2SF                 | 22996                              | ?               |
|                   | 4                               | 4                        | 10            | 4                        | 20000                              | ?               |

NOTE: When 4 codes are transmitted in parallel, two codes shall be transmitted with SF2 and two with SF4. UE categories 1 to 6 support QPSK only. UE category 7 supports QPSK and 16QAM. (TS25.306-7.3.0).

Table 14:HSUPA UE category

#### 4) DC-HSDPA

In DC-HSDPA implementation of this device, the uplink parameters are the same as HSDPA. No additional channels and modulations (16 QAM, and 64 QAM) are supported in uplink. The difference is only in the downlink parameters, where two carriers are supported. HSDPA settings were used on uplink.

For Rel. 8 DC-HSDPA apply the four subtests from HSDPA Release 5 except use fixed reference channel H-Set 12 for DC-HSDPA. And we can apply the same SAR test exclusion criteria used for Rel. 6 HSPA for Rel. 7 HSPA+ and Rel. 8 DC-HSDPA. That is, if the HSPA, HSPA+, or the DC-HSDPA maximum output is not more than 0.25 dB higher than WCDMA, SAR measurement for those modes is not required.

The following tests were completed according to procedures in section 7.3.13 of 3GPP TS 34.108 v9.5.0. A summary of these settings are illustrated below:

Downlink Physical Channels are set as per 3GPP TS34.121-1 v9.0.0 E.5.0

**Table E.5.0: Levels for HSDPA connection setup**

| Parameter<br>During Connection setup | Unit | Value |
|--------------------------------------|------|-------|
| P-CPICH_Ec/Ior                       | dB   | -10   |
| P-CCPCH and SCH_Ec/Ior               | dB   | -12   |
| PICH_Ec/Ior                          | dB   | -15   |
| HS-PDSCH                             | dB   | off   |
| HS-SCCH_1                            | dB   | off   |
| DPCH_Ec/Ior                          | dB   | -5    |
| OCNS_Ec/Ior                          | dB   | -3.1  |

Call is set up as per 3GPP TS34.108 v9.5.0 sub clause 7.3.13

The configurations of the fixed reference channels for HSDPA RF tests are described in 3GPP TS 34.121, annex C for FDD and 3GPP TS 34.122.

The measurements were performed with a Fixed Reference Channel (FRC) H-Set 12 with QPSK

| Parameter                        | Value       |
|----------------------------------|-------------|
| Nominal average inf. bit rate    | 60 kbit/s   |
| Inter-TTI Distance               | 1 TTI's     |
| Number of HARQ Processes         | 6 Processes |
| Information Bit Payload          | 120 Bits    |
| Number Code Blocks               | 1 Block     |
| Binary Channel Bits Per TTI      | 960 Bits    |
| Total Available SMLs in UE       | 19200 SMLs  |
| Number of SMLs per HARQ Process  | 3200 SMLs   |
| Coding Rate                      | 0.15        |
| Number of Physical Channel Codes | 1           |

Table 15: settings of required H-Set 12 QPSK acc. to 3GPP 34.121

Note:

- 1.The RMC is intended to be used for DC-HSDPA mode and both cells shall transmit with identical parameters as listed in the table above.
- 2.Maximum number of transmission is limited to 1,i.e.,retransmission is not allowed. The redundancy and constellation version 0 shall be used.

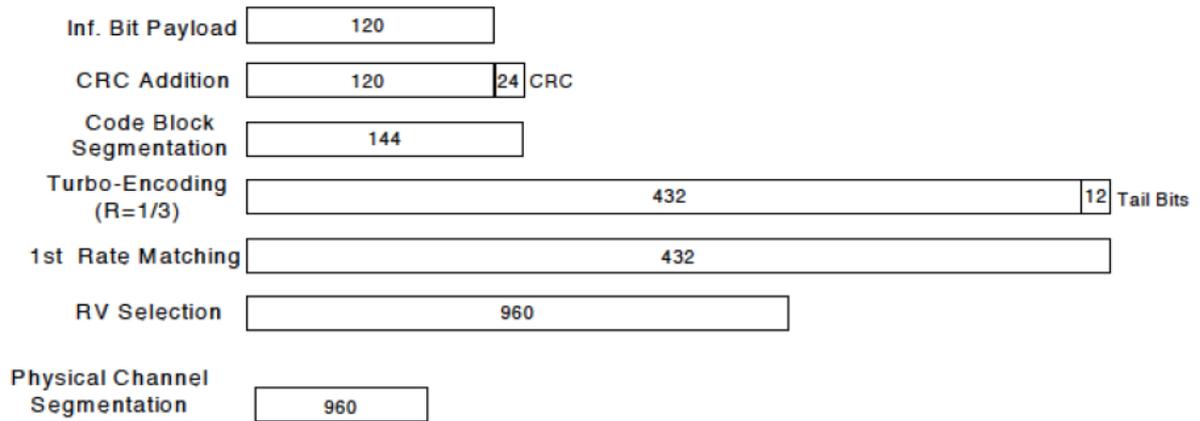


Figure C.8.19: Coding rate for Fixed reference Channel H-Set 12 (QPSK)

The following 4 Sub-tests for HSDPA were completed according to Release 5 procedures. A summary of subtest settings are illustrated below:

| Sub-test <sup>o</sup> | $\beta_c$ <sup>o</sup> | $\beta_d$ <sup>o</sup> | $\beta_d$ (SF) <sup>o</sup> | $\beta_c/\beta_d$ <sup>o</sup> | $\beta_{hs}$ (1) <sup>o</sup> | CM(dB)(2) <sup>o</sup> | MPR (dB) <sup>o</sup> |
|-----------------------|------------------------|------------------------|-----------------------------|--------------------------------|-------------------------------|------------------------|-----------------------|
| 1 <sup>o</sup>        | 2/15 <sup>o</sup>      | 15/15 <sup>o</sup>     | 64 <sup>o</sup>             | 2/15 <sup>o</sup>              | 4/15 <sup>o</sup>             | 0.0 <sup>o</sup>       | 0 <sup>o</sup>        |
| 2 <sup>o</sup>        | 12/15(3) <sup>o</sup>  | 15/15(3) <sup>o</sup>  | 64 <sup>o</sup>             | 12/15(3) <sup>o</sup>          | 24/15 <sup>o</sup>            | 1.0 <sup>o</sup>       | 0 <sup>o</sup>        |
| 3 <sup>o</sup>        | 15/15 <sup>o</sup>     | 8/15 <sup>o</sup>      | 64 <sup>o</sup>             | 15/8 <sup>o</sup>              | 30/15 <sup>o</sup>            | 1.5 <sup>o</sup>       | 0.5 <sup>o</sup>      |
| 4 <sup>o</sup>        | 15/15 <sup>o</sup>     | 4/15 <sup>o</sup>      | 64 <sup>o</sup>             | 15/4 <sup>o</sup>              | 30/15 <sup>o</sup>            | 1.5 <sup>o</sup>       | 0.5 <sup>o</sup>      |

Note 1:  $\Delta$  ACK,  $\Delta$  NACK and  $\Delta$  CQI=8  $A_{hs} = \beta_{hs}/\beta_c = 30/15$   $\beta_{hs} = 30/15 * \beta_c$   
 Note 2: CM=1 for  $\beta_c/\beta_d=12/15$ ,  $\beta_{hs}/\beta_c=24/15$ . For all other combinations of DPDCH, DPCCH and HS-DPCCH the MPR is based on the relative CM difference. This is applicable for only UEs that support HSDPA in release 6 and later releases.  
 Note 3: For subtest 2 the  $\beta_c/\beta_d$  ratio of 12/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signalled gain factors for the reference TFC (TF1, TF1) to  $\beta_c=11/15$  and  $\beta_d=15/15$

Up commands are set continuously to set the UE to Max power.

Note:

- 1.The Dual Carriers transmission only applies to HSDPA physical channels
- 2.The Dual Carriers belong to the same Node and are on adjacent carriers.
- 3.The Dual Carriers do not support MIMO to serve UEs configured for dual cell operation
- 4.The Dual Carriers operate in the same frequency band .
- 5.The device doesn't support the modulation of 16QAM in uplink but 64QAM in downlink for DC-HSDPA mode.
- 6.The device doesn't support carrier aggregation for it just can operate in Release 8.

## 7 SAR Measurement Results

### 7.1 Conducted power measurements

For the measurements a Rohde & Schwarz Radio Communication Tester CMU 200 was used.

SAR drift measured at the same position in liquid before and after each SAR test as below 7.2 chapter.

Note: CMU200 measures GSM peak and average output power for active timeslots. For SAR the timebased average power is relevant. The difference in between depends on the duty cycle of the TDMA signal :

| No. of timeslots                                    | 1       | 2       | 3       | 4       |
|---|---------|---------|---------|---------|
| Duty Cycle  | 1:8.3   | 1:4.1   | 1:2.77  | 1:2.08  |
| timebased avg. power compared to slotted avg. power | -9.19dB | -6.13dB | -4.42dB | -3.18dB |

The signalling modes differ as follows:

| mode | coding scheme | modulation |
|------|---------------|------------|
| GPRS | CS1 to CS4    | GMSK       |
| EDGE | MCS1 to MCS4  | GMSK       |
| EDGE | MCS5 to MCS9  | 8PSK       |

Apart from modulation change (GMSK/8PSK) coding schemes differ in code rate without influence on the RF signal. Therefore one coding scheme per mode was selected for conducted power measurements.

**7.1.1 Conducted power measurements GSM850**

| GSM850            |            | Burst-Averaged output Power (dBm) |       |       | Division Factors | Frame-Averaged output Power (dBm) |              |              |
|-------------------|------------|-----------------------------------|-------|-------|------------------|-----------------------------------|--------------|--------------|
|                   |            | 128CH                             | 190CH | 251CH |                  | 128CH                             | 190CH        | 251CH        |
| GPRS /EDGE (GMSK) | 1 Tx Slot  | 32.23                             | 32.16 | 32.19 | -9.19            | 23.04                             | 22.97        | 23.00        |
|                   | 2 Tx Slots | 31.23                             | 31.20 | 31.21 | -6.13            | <b>25.10</b>                      | <b>25.07</b> | <b>25.08</b> |
|                   | 3 Tx Slots | 29.28                             | 29.28 | 29.20 | -4.42            | 24.86                             | 24.86        | 24.78        |
|                   | 4 Tx Slots | 27.30                             | 27.27 | 27.22 | -3.18            | 24.12                             | 24.09        | 24.04        |
| EDGE (8PSK)       | 1 Tx Slot  | 26.27                             | 26.30 | 26.49 | -9.19            | 17.08                             | 17.11        | 17.30        |
|                   | 2 Tx Slots | 25.81                             | 25.68 | 25.93 | -6.13            | 19.68                             | 19.55        | 19.80        |
|                   | 3 Tx Slots | 23.96                             | 23.89 | 24.03 | -4.42            | 19.54                             | 19.47        | 19.61        |
|                   | 4 Tx Slots | 22.01                             | 21.87 | 22.06 | -3.18            | 18.83                             | 18.69        | 18.88        |

Table 16:Test results conducted power measurement GSM850

Note: 1. The conducted power of GSM850 is measured with RMS detector.

2. Frame-averaged output power was calculated from the measured burst-averaged output power by converting the slot powers into linear units and calculating the energy over 8 timeslots.

3) Per KDB 941225 D303v01,the bolded GPRS 2Ts slots mode was selected for SAR testing according to the highest frame-averaged output power.

**7.1.2 Conducted power measurements GSM1900**

| GSM1900           |            | Burst-Averaged output Power (dBm) |       |       | Division Factors | Frame-Averaged output Power (dBm) |              |              |
|-------------------|------------|-----------------------------------|-------|-------|------------------|-----------------------------------|--------------|--------------|
|                   |            | 512CH                             | 661CH | 810CH |                  | 512CH                             | 661CH        | 810CH        |
| GPRS /EDGE (GMSK) | 1 Tx Slot  | 29.55                             | 29.58 | 29.55 | -9.19            | 20.36                             | 20.39        | 20.36        |
|                   | 2 Tx Slots | 28.55                             | 28.55 | 28.56 | -6.13            | <b>22.42</b>                      | <b>22.42</b> | <b>22.43</b> |
|                   | 3 Tx Slots | 26.60                             | 26.59 | 26.50 | -4.42            | 22.18                             | 22.17        | 22.08        |
|                   | 4 Tx Slots | 24.55                             | 24.54 | 24.53 | -3.18            | 21.37                             | 21.36        | 21.35        |
| EDGE (8PSK)       | 1 Tx Slot  | 25.64                             | 25.50 | 25.71 | -9.19            | 16.45                             | 16.31        | 16.52        |
|                   | 2 Tx Slots | 25.21                             | 24.81 | 25.07 | -6.13            | 19.08                             | 18.68        | 18.94        |
|                   | 3 Tx Slots | 23.16                             | 22.91 | 23.11 | -4.42            | 18.74                             | 18.49        | 18.69        |
|                   | 4 Tx Slots | 21.47                             | 21.29 | 21.51 | -3.18            | 18.29                             | 18.11        | 18.33        |

Table 17:Test results conducted power measurement GSM1900

Note: 1. The conducted power of GSM1900 is measured with RMS detector.

2. Frame-averaged output power was calculated from the measured burst-averaged output power by converting the slot powers into linear units and calculating the energy over 8 timeslots.

3) Per KDB 941225 D303v01,the bolded GPRS 2Ts slots mode was selected for SAR testing according to the highest frame-averaged output power.



### 7.1.3 Conducted power measurements UMTS Band II

| UMTS Band II |              | Conducted Power (dBm) |        |        |
|--------------|--------------|-----------------------|--------|--------|
|              |              | 9262CH                | 9400CH | 9538CH |
| WCDMA        | 12.2kbps RMC | 22.31                 | 22.30  | 21.87  |
|              | 64kbps RMC   | 22.27                 | 22.29  | 21.82  |
|              | 144kbps RMC  | 22.27                 | 22.25  | 21.80  |
|              | 384kbps RMC  | 22.27                 | 22.26  | 21.79  |
| HSDPA        | Subtest 1    | 21.98                 | 21.89  | 21.23  |
|              | Subtest 2    | 21.96                 | 21.97  | 21.36  |
|              | Subtest 3    | 21.86                 | 21.59  | 21.03  |
|              | Subtest 4    | 21.68                 | 21.26  | 21.04  |
| HSUPA        | Subtest 1    | 20.34                 | 20.46  | 19.93  |
|              | Subtest 2    | 19.41                 | 19.55  | 18.96  |
|              | Subtest 3    | 20.40                 | 20.40  | 19.93  |
|              | Subtest 4    | 19.25                 | 19.29  | 18.80  |
|              | Subtest 5    | 20.53                 | 20.47  | 19.90  |
| DC-HSDPA     | Subtest 1    | 21.78                 | 21.92  | 21.13  |
|              | Subtest 2    | 21.83                 | 21.89  | 21.26  |
|              | Subtest 3    | 21.88                 | 21.64  | 21.08  |
|              | Subtest 4    | 21.75                 | 21.13  | 21.06  |

Table 18:Test results conducted power measurement UMTS Band II

Note: The conducted power of UMTS Band II is measured with RMS detector.

## 7.2 SAR measurement Result

- 1) Per KDB447498 D01v05, testing of other required channels within the operating mode of a frequency band is not required when the reported (Scaled) SAR for the middle channel or highest output power channels is  $\leq 0.8 \text{ W/kg}$ . When the maximum output power variation across the required test channels is  $> \frac{1}{2} \text{ dB}$ , instead of the middle channel, the highest output power channel must be used.
- 2) Per KDB865664 D01v01, for each frequency band, repeated SAR measurement is required only when the measured SAR is  $\geq 0.8 \text{ W/kg}$ ; if the deviation among the repeated measurement is  $\leq 20\%$ , and the measured SAR  $< 1.45 \text{ W/kg}$ , only one repeated measurement is required.
- 3) Per KDB941225 and the April 2013 TCB workshop RF exposure slides, when maximum output power is  $\leq \frac{1}{4} \text{ dB}$  higher than without HSPA, HSPA+ or DC-HSDPA using 12.2 kbps RMC, and when maximum SAR for 12.2 kbps RMC is  $\leq 75\%$  of SAR limit, SAR measurement for HSPA, HSPA+ or DC-HSDPA is not required.
- 4) All measurement SAR result is scaled-up to account for tune-up tolerance is compliant.

### 7.2.1 SAR measurement Result of GSM850

| Test Position of Body with 5mm | Channel /Freq.(MHz) | Mode     | SAR (W/kg) |       | Power Drift (dB) | Conducted Power (dBm) | Tune-up Limit (dBm) | Scaled SAR <sub>1-g</sub> (W/kg) | Liquid Temp. |
|--------------------------------|---------------------|----------|------------|-------|------------------|-----------------------|---------------------|----------------------------------|--------------|
|                                |                     |          | 1-g        | 10-g  |                  |                       |                     |                                  |              |
| Front Side                     | 251/848.8           | GPRS 2TS | 0.945      | 0.580 | 0.110            | 31.21                 | 32.00               | 1.134                            | 21.4°C       |
| Front Side                     | 190/836.6           | GPRS 2TS | 0.947      | 0.585 | -0.170           | 31.20                 | 32.00               | <b>1.139</b>                     | 21.4°C       |
| Front Side -repeated*          | 190/836.6           | GPRS 2TS | 0.920      | 0.569 | 0.020            | 31.20                 | 32.00               | 1.106                            | 21.4°C       |
| Front Side                     | 128/824.2           | GPRS 2TS | 0.881      | 0.547 | 0.170            | 31.23                 | 32.00               | 1.052                            | 21.4°C       |
| Rear Side                      | 190/836.6           | GPRS 2TS | 0.656      | 0.411 | 0.070            | 31.20                 | 32.00               | 0.789                            | 21.4°C       |
| Left Side                      | 190/836.6           | GPRS 2TS | 0.490      | 0.309 | -0.160           | 31.20                 | 32.00               | 0.589                            | 21.4°C       |
| Right Side                     | 190/836.6           | GPRS 2TS | 0.208      | 0.146 | -0.160           | 31.20                 | 32.00               | 0.250                            | 21.4°C       |
| Tip Side                       | 190/836.6           | GPRS 2TS | 0.016      | 0.010 | 0.070            | 31.20                 | 32.00               | 0.019                            | 21.4°C       |

Table 19: Test results Body SAR GSM850

Note:

- 1) \* - repeated at the highest SAR measurement according to the FCC KDB 865664.

**7.2.2 SAR measurement Result of GSM1900**

| Test Position of Body with 5mm | Channel /Freq.(MHz) | Mode     | SAR (W/kg) |       | Power Drift (dB) | Conducted Power (dBm) | Tune-up Limit (dBm) | Scaled SAR <sub>1-g</sub> (W/kg) | Liquid Temp. |
|--------------------------------|---------------------|----------|------------|-------|------------------|-----------------------|---------------------|----------------------------------|--------------|
|                                |                     |          | 1-g        | 10-g  |                  |                       |                     |                                  |              |
| Front Side                     | 810/1909.8          | GPRS 2TS | 0.909      | 0.477 | 0.160            | 28.56                 | 29.00               | 1.006                            | 21.4°C       |
| Front Side                     | 661/1880            | GPRS 2TS | 0.920      | 0.485 | -0.150           | 28.55                 | 29.00               | <b>1.020</b>                     | 21.4°C       |
| Front Side -repeated*          | 661/1880            | GPRS 2TS | 0.904      | 0.476 | 0.140            | 28.55                 | 29.00               | 1.003                            | 21.4°C       |
| Front Side                     | 512/1850.2          | GPRS 2TS | 0.886      | 0.468 | 0.120            | 28.55                 | 29.00               | 0.983                            | 21.4°C       |
| Rear Side                      | 810/1909.8          | GPRS 2TS | 0.811      | 0.446 | 0.050            | 28.56                 | 29.00               | 0.897                            | 21.4°C       |
| Rear Side                      | 661/1880            | GPRS 2TS | 0.795      | 0.436 | 0.040            | 28.55                 | 29.00               | 0.882                            | 21.4°C       |
| Rear Side                      | 512/1850.2          | GPRS 2TS | 0.741      | 0.405 | 0.070            | 28.55                 | 29.00               | 0.822                            | 21.4°C       |
| Left Side                      | 661/1880            | GPRS 2TS | 0.477      | 0.264 | -0.190           | 28.55                 | 29.00               | 0.529                            | 21.4°C       |
| Right Side                     | 661/1880            | GPRS 2TS | 0.131      | 0.074 | 0.010            | 28.55                 | 29.00               | 0.145                            | 21.4°C       |
| Tip Side                       | 661/1880            | GPRS 2TS | 0.023      | 0.014 | -0.060           | 28.55                 | 29.00               | 0.026                            | 21.4°C       |

Table 20: Test results Body SAR GSM1900

Note:

1) \* - repeated at the highest SAR measurement according to the FCC KDB 865664.

**7.2.3 SAR measurement Result of UMTS Band II**

| Test Position of Body with 5mm | Channel /Freq.(MHz) | Mode | SAR (W/kg) |       | Power Drift (dB) | Conducted Power (dBm) | Tune-up Limit (dBm) | Scaled SAR <sub>1-g</sub> (W/kg) | Liquid Temp. |
|--------------------------------|---------------------|------|------------|-------|------------------|-----------------------|---------------------|----------------------------------|--------------|
|                                |                     |      | 1-g        | 10-g  |                  |                       |                     |                                  |              |
| Front Side                     | 9262/1852.4         | RMC  | 0.702      | 0.368 | 0.020            | 22.31                 | 23.00               | 0.823                            | 21.4°C       |
| Front Side                     | 9400/1880           | RMC  | 0.868      | 0.458 | -0.020           | 22.30                 | 23.00               | 1.020                            | 21.4°C       |
| Front Side                     | 9538/1907.6         | RMC  | 0.676      | 0.359 | 0.150            | 21.87                 | 23.00               | 0.877                            | 21.4°C       |
| Rear Side                      | 9262/1852.4         | RMC  | 0.770      | 0.419 | -0.100           | 22.31                 | 23.00               | 0.903                            | 21.4°C       |
| Rear Side                      | 9400/1880           | RMC  | 0.991      | 0.541 | -0.050           | 22.30                 | 23.00               | <b>1.164</b>                     | 21.4°C       |
| Rear Side -repeated*           | 9400/1880           | RMC  | 0.953      | 0.524 | -0.100           | 22.30                 | 23.00               | 1.120                            | 21.4°C       |
| Rear Side                      | 9538/1907.6         | RMC  | 0.838      | 0.462 | -0.020           | 21.87                 | 23.00               | 1.087                            | 21.4°C       |
| Left Side                      | 9400/1880           | RMC  | 0.585      | 0.320 | 0.150            | 22.30                 | 23.00               | 0.687                            | 21.4°C       |
| Right Side                     | 9400/1880           | RMC  | 0.163      | 0.089 | 0.050            | 22.30                 | 23.00               | 0.192                            | 21.4°C       |
| Tip Side                       | 9400/1880           | RMC  | 0.030      | 0.019 | -0.150           | 22.30                 | 23.00               | 0.035                            | 21.4°C       |

Table 21: Test results Body SAR UMTS Band II

Note:

- 1) \* - repeated at the highest SAR measurement according to the FCC KDB 865664.



**Appendix A. System Check Plots**  
(Pls See Appendix A.)

**Appendix B. SAR Measurement Plots**  
(Pls See Appendix B.)

**Appendix C. Calibration Certificate**  
(Pls See Appendix C.)

**Appendix D. Photo documentation**  
(Pls See Appendix D.)

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**End**